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(56) Documents Cited
WO 1996/038930 A1 **US 6031828 A**
US 5991329 A **US 5815798 A**
US 5809093 A

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UK CL (Edition T) **H4L** LDTP LETXX
INT CL[7] **H04B** 7/005
Other:

(54) Abstract Title
Transmission power control in a wireless transmission system

(57) Transmission power in a point-to-multipoint wireless transmission system is controlled by an automatic gain control (AGC) method in which an access point (AP) transmits, in a downstream signal, sequential data frames containing a power control identifier field which includes a unique identifier and a time delay to a plurality of subscriber units (SU); an SU receives and stores the identifier and after the appropriate delay, transmits an upstream test sequence in the power control test field; causing the AP to determine the received power and to transmit a power adjustment field at a later time, causing the SU to adjust its output power. A flag may be used to indicate whether the adjusted SU transmit power is within a given tolerance band for the test sequence received by the AP. The SU is able to wait for a random number of frames before transmitting the upstream test sequence. Communication between the AP and SUs may be by frequency division duplex time division multiple access (FDDCDMA).

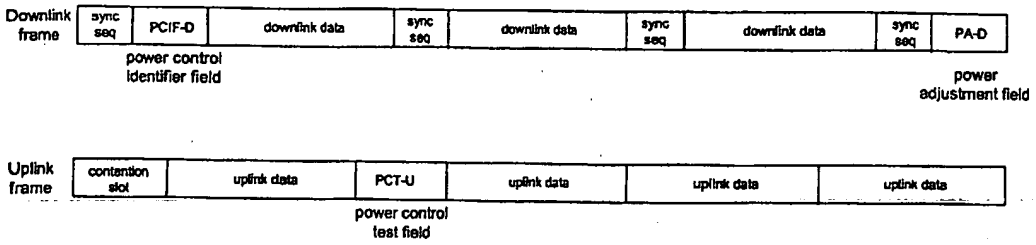

Figure 2

GB 2 376 381 A

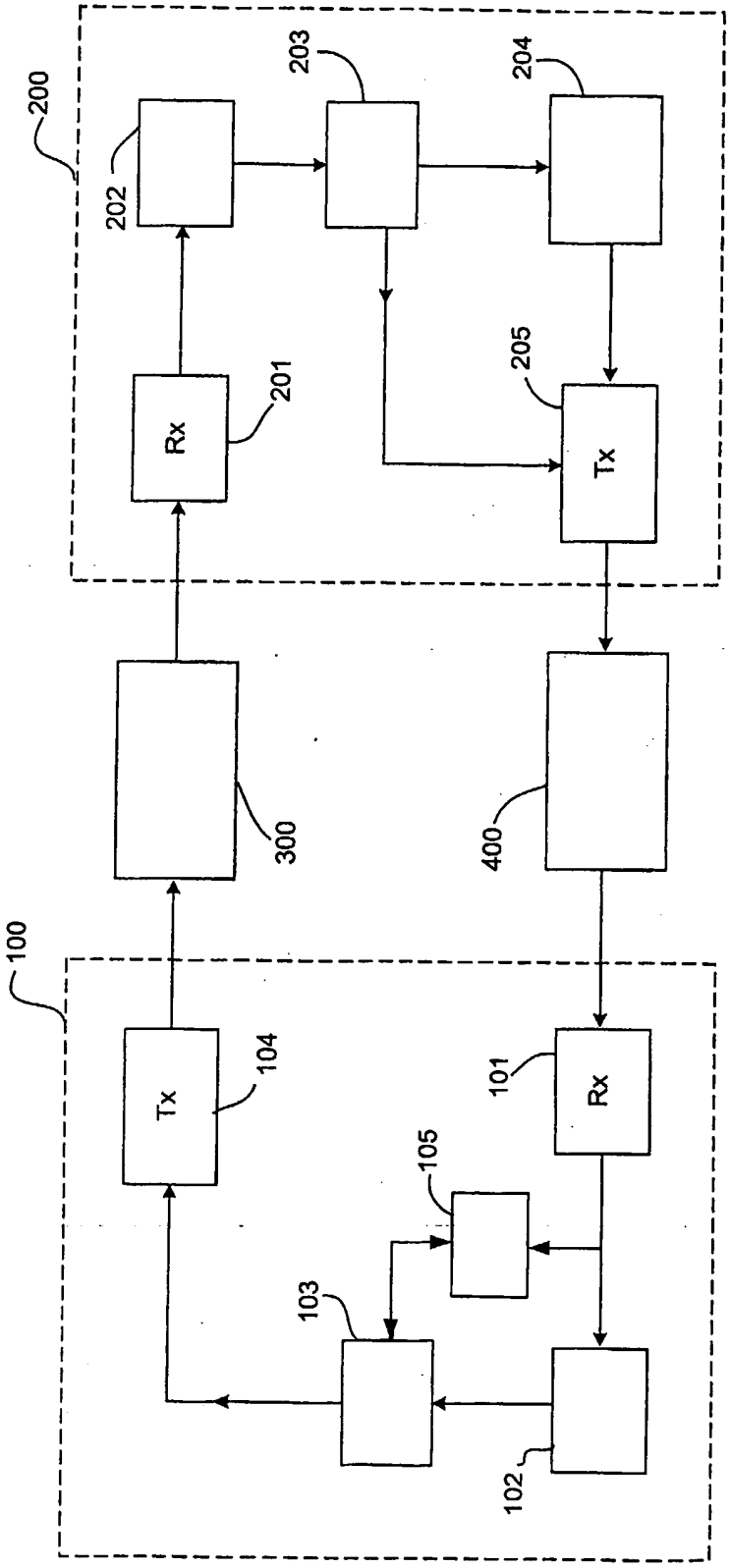
200
202
203
204
205
Rx
201
Tx
300
400
100
Tx
104
101
Rx
105
103
102

Figure 1

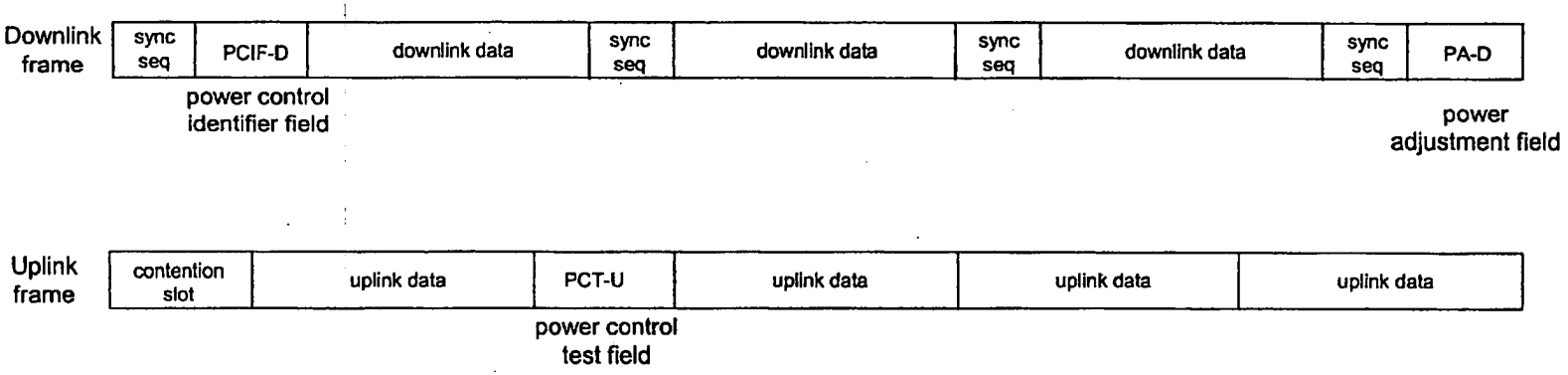

Figure 2

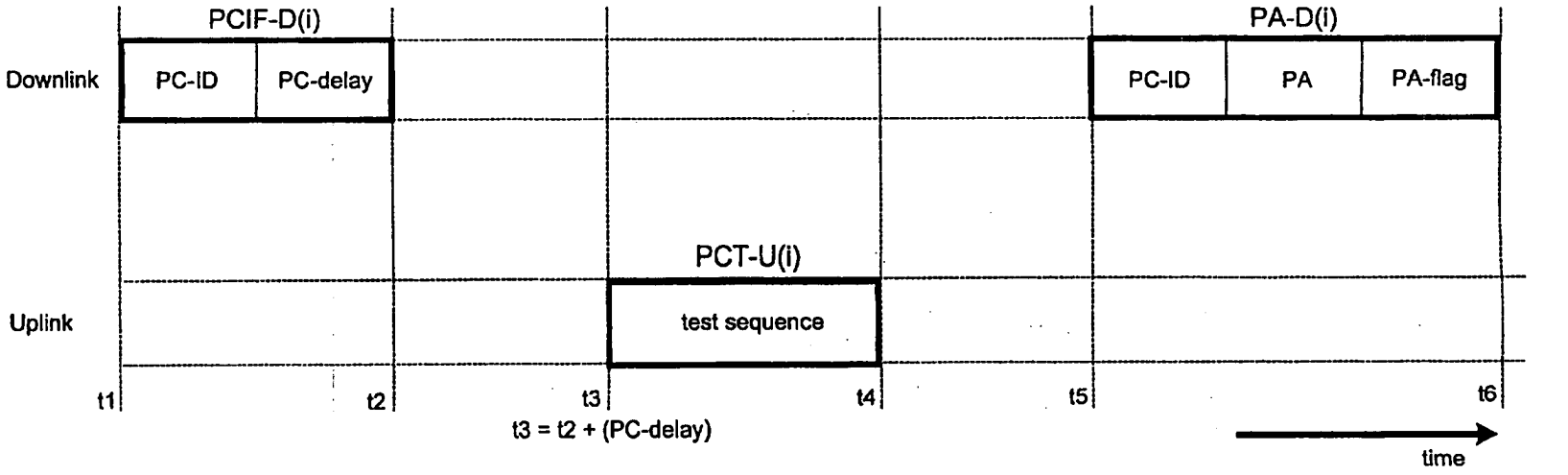

Figure 3

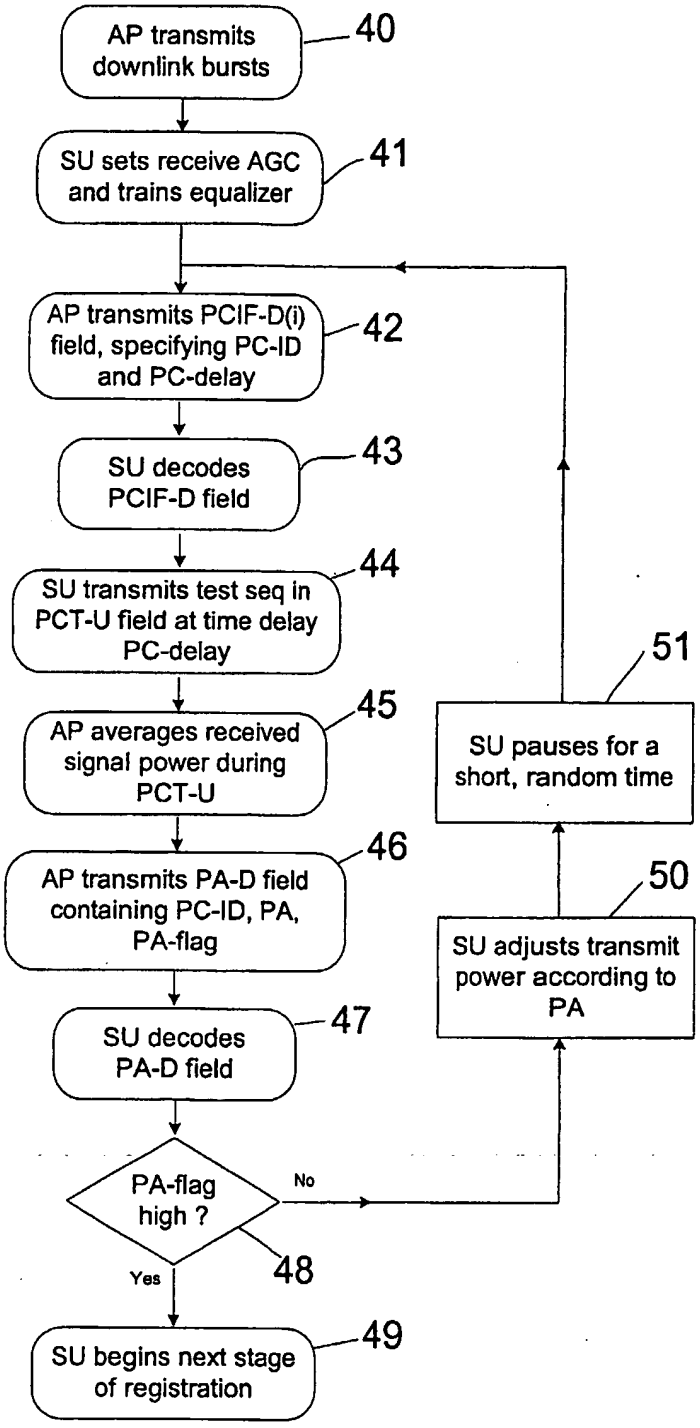
AP transmits downlink bursts
40
SU sets receive AGC and trains equalizer
41
AP transmits PCIF-D(i) field, specifying PC-ID and PC-delay
42
SU decodes PCIF-D field
43
SU transmits test seq in PCT-U field at time delay PC-delay
44
AP averages received signal power during PCT-U
45
AP transmits PA-D field containing PC-ID, PA, PA-flag
46
SU decodes PA-D field
47
PA-flag high ?
48
No
Yes
SU begins next stage of registration
49
SU adjusts transmit power according to PA
50
SU pauses for a short, random time
51

Figure 4

WIRELESS TRANSMISSION SYSTEM AND METHOD

The invention relates to a method of setting the transmit power of a subscriber unit (SU) in a point to multipoint wireless transmission system comprising an access point (AP) and a plurality of SUs. The invention further relates to a point to multipoint wireless transmission system comprising an access point (AP) and a plurality of subscriber units (SU) and to a subscriber unit and to an access point for use in such a wireless transmission system.

In fixed wireless access systems the signal processing burden at the access point can be excessive since the access point may have to deal with many individual subscriber units. In frequency division duplex systems this burden is increased with respect to time division duplex systems as each subscriber has two channels, i.e. a downstream channel from the AP to the SU at one frequency and an upstream channel from the SU to the AP at a second frequency. These two channels may have different characteristics with respect to excess delay spread and attenuation.

Before data transfer between a subscriber unit and access point can begin it is necessary to set up the communication link parameters. One of these parameters is the upstream power control. In a point to multipoint system each subscriber unit only receives data from a single access point and downstream data bursts can often

be heard by all the subscriber units. Consequently each subscriber unit has plenty of time for automatic gain control adjustment on the downstream channel, that is the communication link from the access point to the subscriber unit. On the upstream channel, that is the communication data link from the subscriber unit to the access point, however, signal transmission occurs between many different subscriber units and a single access point. Consequently upstream power control is important to minimise interference and improve frequency re-use. In order to maximise system efficiency the access point must have the capability to receive many short bursts from different subscriber units in quick succession. To enable this to be achieved the received power from each subscriber unit must be correctly adjusted. This creates difficult problems for automatic gain control at the access point because there is very little time available between bursts from different subscriber units to adjust the automatic gain control in the access point. Clearly the output power from different subscriber units may differ depending on the actual power at which the subscriber transmits and the distance or attenuation of the communications link between the subscriber unit and the access point.

US Patent No. 5896411 discloses an enhanced mechanism for the reverse link power control in a wireless communication system, especially for high speed data applications and fixed wireless communication applications, which dynamically adjusts the power control step size of the reverse link power control. The power control step size is dynamically adjusted based on various factors including types of service, number of reverse supplemental code channels, total received power at base station, estimated

diversity gain and required mobility, among others. The system, which includes stationary infrastructure, can query a subscriber unit's capability in the support of a predefined set of power control step sizes before assigning it the subscriber unit. Furthermore, the subscriber unit may decide its optimised power control step size based on certain feedbacks from the system.

US Patent No. 5815798 discloses apparatus for controlling transmitting power in a wireless telecommunications system comprising;
a transmitter at a central terminal for transmitting a downlink signal, the downlink signal including a power control signal;
a receiver at a subscriber terminal for receiving the downlink signal, the receiver of the subscriber terminal operable to extract the power control signal from the downlink signal;
a transmitter at the subscriber terminal for transmitting an uplink signal, the transmitter of the subscriber terminal operable to receive the power control signal, the power control signal operable to adjust a transmitting power of the transmitter.

These systems assume that the registration process of a subscriber unit with the access point is complete before upstream channel power is adjusted. Consequently, the access point has to determine the identity of the subscriber unit before the upstream channel power is adjusted to the optimum value. This means that the access point has to be capable of performing the registration process with a non-optimum upstream data burst or to have a very fast acting automatic gain control facility.

Either alternative adds to the cost and complexity of the access point.

The invention provides a method of setting the transmit power of a subscriber unit (SU) in a point to multipoint wireless transmission system comprising an access point (AP) and a plurality of SUs, the method comprising the steps of:

a) causing the AP to transmit sequential downstream data frames, at least some of which contain a power control identifier field, each power control identifier field containing a unique identifier and defining a time at which an associated upstream power control test field occurs;

b) causing the SU, as a result of receiving and decoding the power control identifier field, to store the unique identifier and to generate and transmit an upstream test sequence in the power control test field;

c) causing the AP to determine the received power of the test sequence;

d) causing the AP to transmit a power adjustment field at a later time in the frame or in a subsequent frame, the power adjustment field containing the unique identifier from the power control identifier field and data representing a required transmit power adjustment; and

e) causing the SU to adjust its output power when it detects a power adjustment field containing the stored unique identifier in accordance with the received power adjustment data.

The method according to the invention enables the transmit power of the subscriber unit to be adjusted without the

access point having to establish which subscriber unit is transmitting. Thus the access point does not need to know the subscriber unit identity and in short burst point to multipoint systems it is an advantage if the upstream channel power control can be achieved before the subscriber unit identity is established. This requirement is even more critical in a frequency division duplex system where the upstream and downstream channels are different and so measurement of downstream channel power at the subscriber unit does not provide a reliable estimate for the upstream channel power control. Further, in order to enable a communication system to use partial or full pre-coding of data transmitted over the upstream channel it is necessary to set the upstream channel power control before setting pre-coder coefficients and establishing the subscriber unit identity.

Steps b) to e) may be repeated until transmit power adjustment values fall below a threshold value. The power adjustment field may contain a flag indicating whether the transmit power has been adjusted so that the received signal power of the test sequence at the AP is within a given tolerance band of a preset power level.

By providing a flag in the power adjustment field the subscriber unit can be inhibited from attempting to obtain further power adjustment signals from the access point. Thus an individual subscriber unit will no longer attempt to use the power control test field leaving the other subscriber units free to do so.

In step b) the subscriber unit may wait for a random number of frames before transmitting the upstream test

sequence. This minimises the probability of two subscriber units trying to obtain power control adjustment data in the same frame.

The invention further provides a point to multipoint wireless transmission system comprising an access point (AP) and a plurality of subscriber units (SUs) wherein:

the AP comprises means for transmitting sequential downstream data frames, at least some of which contain a power control identifier field, each power control identifier field containing a unique identifier and defining a time at which an associated upstream power control test field occurs;

the SU comprises means for receiving the transmitted downstream data frames and decoding the power control identifier field, means for storing the unique identifier and for generating and transmitting an upstream test sequence in the power control test field;

the AP further comprises means for determining the received power of the test sequence and for transmitting a power adjustment field at a later time in the frame or in a subsequent frame, the power adjustment field containing the unique identifier from the power control identifier field and data representing a required transmit power adjustment; and

the SU further comprises means for adjusting its output power when it detects a power adjustment field containing the stored unique identifier in accordance with the received power adjustment data.

The invention still further provides a subscriber unit (SU) for use in a point to multipoint wireless transmission system as set forth in the preceding

paragraph, the SU comprising means for receiving from the AP downstream data frames and decoding the power control identifier field, means for storing the unique identifier and for generating and transmitting an upstream test sequence in the power control test field, and means for adjusting its output power, when it detects a power adjustment field in a downstream data frame transmitted by the AP containing the stored unique identifier, in accordance with the received power adjustment data.

The invention yet further provides an access point (AP) for use in a system as set forth in the penultimate preceding paragraph, the AP comprising means for transmitting sequential downstream data frames at least some of which contain a power control identifier field, each power control identifier field containing a unique identifier and defining a time at which an associated upstream power control test field occurs, means for receiving an upstream test sequence from subscriber units (SUs), means for determining the received power of the test sequence, and means for transmitting a power adjustment field at a later time in the frame or in a subsequent frame, the power adjustment field containing the unique identifier from the power control identifier field and data representing a required transmit power adjustment.

The above and other features and advantages of the invention will be apparent from the following description by way of example, of an embodiment of the invention with reference to the accompanying drawings, in which;

Figure 1 shows in block schematic form an embodiment of a point to multipoint wireless transmission system according to the invention;

Figure 2 shows upstream and downstream frame structures for communication between the access point and subscriber units of the system shown in Figure 1;

Figure 3 shows in greater detail the structure of the power control identifier field, the power adjustment field and the test sequence of the frames shown in Figure 2; and

Figure 4 is a flow diagram illustrating a method of setting the transmit power of a subscriber unit in a point to multipoint wireless transmission system according to the invention.

Figure 1 shows in block schematic form a point to multipoint wireless transmission system according to the invention comprising an access point 100 and a subscriber unit 200. In a practical system there will be a plurality of subscriber units which will each take the form shown as the subscriber unit 200. In the system of the embodiment communication between the access point 100 and the subscriber unit 200 is by means of a frequency division duplex time division multiple access protocol. That is, the downstream channel 300 between the access point and the subscriber units is at a first frequency while the upstream channels 400 between the subscriber units and the access point are at a different frequency and the subscriber units have to contend for access to the upstream channel to the access point. The access point 100 includes a receiver 101 which receives transmissions from the subscriber units 200. The receiver 101 converts the input signal into a form which can be applied to a decoder 102 which decodes the data received from the

subscriber units and feeds decoded data to a control and timing arrangement 103. The data fed to the control and timing arrangement 103 will be with respect to control functions for the access point. The parts of the access point 100 which receive the information data are not shown as they are not relevant to the present invention. The access point 100 also includes a transmitter 104 which transmits data from the access point to the subscriber units 200 over the downstream channel 300. Again those parts of the access point which deal with the transmission of information data are not further shown in this diagram as they are not relevant to the present invention.

The subscriber unit 200 comprises a receiver 201 which receives the signal transmitted by the access point 100 and converts it into a form which can be applied to a decoder 202 which decodes the data received by the receiver 201 and a control and timing arrangement 203 which receives and acts upon the decoded control data received from the access point 100. The control and timing arrangement 203 controls a test sequence generator 204 which feeds a test sequence to a transmitter 205. The transmitter 205 further receives control inputs from the control and timing arrangement 203.

The embodiment of the invention shown in Figure 1 enables a procedure for adjusting upstream channel power control without requiring a knowledge of either the subscriber unit identity or the upstream channel response at the access point. It uses special fields in upstream and downstream frames for adjusting the transmit power of the subscriber unit in such a manner that the signals arriving

from each subscriber unit have substantially the same signal strength when they arrive at the access point.

Before registration has taken place, that is before the subscriber unit is identified to the access point, the subscriber unit listens to downlink transmission broadcast from the access point. The subscriber unit first adjusts the AGC circuitry in its receiver 201 in order to receive the signal transmitted by access point at the correct amplitude. The decoder 202 and control and timing arrangement 203 then detect known training sequences embedded at intervals in the downstream signal and use these known sequences to achieve timing synchronisation and downstream channel estimation and to set up the coefficients of an equaliser within its receiver 201. Once the equaliser at the subscriber unit has been initialised, the downstream control and information data from the access point can be decoded by the subscriber unit. In systems where the upstream and downstream channels are not the same, for example, a frequency division duplex system or where channel characteristics are changing rapidly, the downstream power control and channel response information cannot be used for the upstream channel as its response is not correlated with the downstream channel. Further, in a short burst point to multipoint system with many subscriber units transmitting to a single access point there is not sufficient time for the access point to adjust its automatic gain control circuits between bursts of data from different subscriber units.

In order to enable the access point to control the adjustment of the transmit power of the subscriber units

without the access point requiring a knowledge of which subscriber unit is transmitting the access point 100 transmits downstream frames which include at least one power control identifier field as shown in Figure 2 and labelled PCIF-D. The upstream frame includes a power control test field PCT-U which is associated with a power control identifier field PCIF-D. As shown in Figure 3 the power control identifier field PCIF-D(i) consists of two parts; the first part is a unique power control identifier PC-ID and the second is a timing offset PC-delay which specifies the timing delay of the associated upstream field PCT-U(i) within the upstream frame. When a subscriber unit wishes to begin the power control process it decodes the downstream frame and extracts the next occurring power control identifier field PCIF-D(i) which specifies the power control identifier PC-ID and the power control delay PC-delay for the corresponding power control test field PCT-U(i). The subscriber unit stores the power control identifier PC-ID in memory. The subscriber unit then transmits a test sequence of constant amplitude data, which may be a fixed sequence of data, during the upstream field PCT-U(i) at a time location specified by PC-delay. The access point listens for any received signals during the uplink field PCT-U(i) and averages the received signal power over the upstream test sequence PCT-U(i). The average test power is then stored in a table at a position referenced by the power control identifier PC-ID. For each power control identifier field PCIF-D(i) there is also a downstream field known as the power adjust field PA-D(i) which may occur either later in the same downstream frame or in a subsequent downstream frame.

After measuring the average power received during the PCT-U(i) field in the upstream frame, the access point calculates a power adjustment value PA for the subscriber unit. The power adjustment value PA may indicate a factor by which the transmit power of the subscriber unit should be increased or decreased to cause the received signal strength of the transmitted upstream signal to reach a desired level. The access point then transmits a power adjustment field PA-D in the downstream frame which contains the power control identifier PC-ID followed by the value PA which is the power adjustment factor followed by a flag PA-flag. The access point does not at this time have any knowledge of which subscriber unit was transmitting during the uplink power control test field PCT-U(i). The subscriber unit listens to all subsequent power adjust fields PA-D transmitted in the downstream frame after the upstream power control test field PCT-U(i) was transmitted. For each power adjust field PA-D the subscriber unit checks to see whether the power control identity PC-ID matches the power control identity PC-ID stored in the subscriber unit. If a match is found then the subscriber unit adjusts its transmit power in accordance with the power adjust value in the PA-D field. Using this new power level, the subscriber unit may then transmit a further test sequence in a later upstream power control test field PCT-U and the process may be repeated until the power adjustment values returned from the access point during the corresponding PA-D field have stabilised to a sufficiently small value.

It will be apparent that this procedure enables the access point to transmit power control instructions to a specific subscriber unit without needing to know the subscriber

unit identity. The access point is able to detect the power level of a signal received in a power control test field PCT-U and knows that this signal has been transmitted in response to a power control identifier field PCIF-D which contained a unique number. It then re-uses that unique number in a subsequent power adjust field and only that subscriber unit which has stored the unique number and transmitted the power control test field PCT-U will react to the power adjustment value PA.

The power adjust field PA-D may also contain a flag PA-flag which is set by the access point to indicate to the subscriber unit whether or not any further adjustment is required in the transmit power. If the PA-flag is low then this indicates to the subscriber unit that further upstream power adjustment is required. If the PA-flag is high then this indicates to the subscriber unit that the upstream power is now correctly adjusted and so the next stage of registration, for example, channel estimation or pre-coder setup may begin.

It may be advantageous for the subscriber unit to wait for a random number of power control identifier fields PCIF-D to occur before attempting to send another test sequence for power control adjustment. The reason for this is that for any power control test PCT-U uplink field it is possible that more than one subscriber unit may try to send a test sequence at the same time. Since the access point has no knowledge of which subscriber unit is transmitting during any upstream power control test field PCT-U(i) all received signal power during this field is simply averaged. If more than one subscriber unit transmits during any PCT-U field then it is likely that

the received power will be higher than if each was transmitting alone. This will cause the power adjust signal returned by the access point to cause all those subscriber units to reduce their transmit power by too great amount. By forcing each subscriber unit to repeat the adjustment procedure after a random delay the probability of each of those subscriber units subsequently using the same power control test field PCT-U(i) is reduced.

Additionally, it may be desired to cause a subscriber unit to transmit a further test sequence during a power control test field PCT-U in order to maintain its transmit power at the correct level. A timer may be provided at each subscriber unit which is reset at the end of each complete power adjustment process. After a given time interval, the timer will expire and indicate to the subscriber unit that it should begin the power adjustment procedure again to ensure that its transmit level remains at the required power. By this means the subscriber unit may automatically adjust its transmit power periodically to compensate for changing channel characteristics.

After registration has occurred, an alternative is that if the access point detects that the power level of the upstream data from a particular subscriber unit is incorrect the access point may use a conventional downstream data or control field to instruct the subscriber unit that its power level is incorrect. This may then either cause the subscriber unit to perform the power adjustment procedure which has been described above or may involve the access point using a conventional downstream data or control field to directly instruct the

subscriber unit as to what power level adjustment should be made.

The power adjustment data may take a number of alternative forms. It may indicate the absolute signal strength of the received signal at the access point so that the subscriber unit can calculate the amount by which the transmitted power should be increased or decreased from a knowledge of the signal strength that the access point should, ideally, receive. Alternatively, it may be told the difference between the actual signal strength of the received signal and the desired signal strength, in which case it will have to determine the proportionate increase or decrease in transmitted power that is required. A further possibility is that the power adjustment field gives a percentage increase or decrease in received signal strength required by the access point. Clearly, if the power adjustment data gives the adjustment to be made in absolute terms, then the subscriber unit needs to transform that into the increase or decrease in power transmitted by the transmitter that is required in order to make that absolute increase or decrease in the strength of the signal received by the access point. If, however, the access point provides data which informs the subscriber unit of a percentage increase or decrease that is required in order to bring the received signal strength to the ideal level then the subscriber unit does not have to make any calculations but merely to increase or decrease the transmitted power by the appropriate percentage. This latter solution may, however, require more calculations to be performed in the access point and there are good reasons for transferring as much of the processing of data to the subscriber unit as possible

since each subscriber unit has more time to carry out these calculations than the access point. An access point may have to service upwards of one thousand subscriber units, each having different channel characteristics in the upstream direction.

Figure 4 is a flow diagram illustrating the power control adjustment procedure according to the invention. The process starts, step 40, with the access point transmitting downstream bursts which may be received by all the subscriber units. Step 41 represents the subscriber unit setting the AGC circuit is its receiver and training its equaliser. The next step in the procedure, step 42, consists of the access point transmitting power control identification fields PCIF-D(i) which specify a power control identifier PC-ID, which is a unique number and changes for each power control identification field PCIF-D(i), and a power control delay PC-delay which defines the time at which the subscriber unit should transmit a power control test field PCT-U(i). Step 43 consists of the subscriber unit decoding the power control identifier field PCIF-D(i) and storing the power control identifier PC-ID(i) number. Step 44 consists of the subscriber unit transmitting a test sequence in the power control test field PCT-U(i) at a time delay PC-delay, from receipt of the power control identifier field PCIF-D(i), which is defined in the power control identifier field PC-ID. Step 45 consists of the access point averaging the received signal strength during the power control test field PCT-U(i) and generating a power adjustment factor PA using the averaged received signal strength. Step 46 consists of the access point transmitting, in the power adjustment field PA-D, data

containing the power control identity PC-ID, the power adjustment PA, and the power adjustment flag PA-flag. Step 47 then consists of the subscriber unit decoding the power adjustment field PA-D. Step 48 consists of a decision being made as to whether the PA-flag is high. If so, that means that the power adjustment has been completed and that the access point is receiving transmissions from the subscriber unit at the correct received signal strength. Step 49 then consists of the subscriber unit beginning the next stage of registration. If, in step 48, it is detected that the PA-flag is low then the next step, step 50, consists of the subscriber unit adjusting the transmit power using to the data in the power adjust portion PA of the power adjustment field PA-D(i). Step 51 consists of the subscriber unit pausing for a short random time before attempting to decode a further power control identification field PCIF-D(i). The procedure from step 51 then iterates back into step 42 and steps 42 to 51 are repeated until the PA-flag becomes high.

The method and system according to the invention are particularly advantageous when applied to wireless systems using frequency division duplex but could equally well be used in other systems for example time division duplex systems. It also has particular application where an access point receives data from a plurality of subscriber units in short bursts where rapidly varying received signal strengths may otherwise occur. It has the advantage over prior art systems that it does not require the identity of the subscriber unit to be known to the access point before the power control adjustment procedure can be carried out. Consequently, there is no need for

the access point to be arranged so that it can identify the subscriber unit without having previously set the received signal strength of transmissions from the subscriber unit to the optimum value. This enables a simplification of the receiving and decoding circuits in the access point giving a consequent cost reduction. The power control algorithms used in the prior art documents referred to in the introduction require the identity of the subscriber unit to be known to the access point before the access point can transmit the power control adjustment data to the appropriate subscriber unit.

CLAIMS

1. A method of setting the transmit power of a Subscriber Unit (SU) in a point to multi-point wireless transmission system comprising an Access Point (AP) and a plurality of SUs, the method comprising the steps of:

a) causing the AP to transmit sequential downstream data frames, at least some of which contain a power control identifier field, each power control identifier field containing a unique identifier and defining a time at which an associated upstream power control test field occurs;

b) causing the SU, as a result of receiving and decoding the power control identifier field, to store the unique identifier and to generate and transmit an upstream test sequence in the power control test field;

c) causing the AP to determine the received power of the test sequence;

d) causing the AP to transmit a power adjustment field at a later time in the frame or in a subsequent frame, the power adjustment field containing the unique identifier from the power control identifier field and data representing a required transmit power adjustment; and

e) causing the SU to adjust its output power when it detects a power adjustment field containing the stored unique identifier in accordance with the received power adjustment data.

2. A method as claimed in Claim 1 in which steps b) to e) are repeated until transmit power adjustment values reach a threshold value.

3) A method as claimed in Claim 1 or Claim 2 in which the power adjustment field contains a flag indicating whether the transmit power has been adjusted so that the received signal power of the test sequence at the AP is within a given tolerance band of a preset power level.

4) A method as claimed in any preceding claim in which in step b) the SU waits for a random number of frames before transmitting the upstream test sequence.

5) A method as claimed in any preceding claim in which communication between the AP and the Sus is by frequency division duplex time division multiple access.

6) A method of setting the transmit power of a Subscriber Unit (SU) in a point to multi-point wireless transmission system comprising an Access Point (AP) and a plurality of SUs, the method being substantially as described herein with reference to the accompanying drawings.

7) A point to multi-point wireless transmission system comprising an Access Point (AP) and a plurality of SUs, wherein:

the AP comprises means for transmitting sequential downstream data frames, at least some of which contain a power control identifier field, each power control identifier field containing a unique identifier and defining a time at which an associated upstream power control test field occurs;

the SU comprises means for receiving the transmitted downstream data frames and decoding the power control identifier field, means for storing the unique identifier

and for generating and transmitting an upstream test sequence in the power control test field;

the AP further comprises means for determining the received power of the test sequence and for transmitting a power adjustment field at a later time in the frame or in a subsequent frame, the power adjustment field containing the unique identifier from the power control identifier field and data representing a required transmit power adjustment; and

the SU further comprises means for adjusting its output power when it detects a power adjustment field containing the stored unique identifier in accordance with the received power adjustment data.

8) A system as claimed in Claim 7 in which the power adjustment field includes a flag to indicate whether the power received at the AP is within a given tolerance band of a preset power level, and the SU further comprises means responsive to the detection of said flag to inhibit further transmission of the upstream test sequence.

9) A system as claimed in Claim 7 or Claim 8 in which the SU comprises means for waiting for a random number of frames before transmitting the upstream test sequence.

10) A system as claimed in any of Claims 7 to 9 in which communication between the AP and SUs is by a frequency division duplex time division multiple access protocol.

11) A point to multi-point wireless transmission system comprising an Access Point (AP) and a plurality of

SUs substantially as described herein with reference to the accompanying drawings.

12) A Subscriber Unit (SU) for use in a point to multi-point wireless transmission system as claimed in any of Claims 7 to 11, the SU comprises means for receiving from the AP downstream data frames and decoding the power control identifier field, means for storing the unique identifier and for generating and transmitting an upstream test sequence in the power control test field, and means for adjusting its output power, when it detects a power adjustment field in a downstream data frame transmitted by the AP, containing the stored unique identifier, in accordance with the received power adjustment data.

13) An SU as claimed in Claim 12 comprising means responsive to detection of a flag in the received power adjustment field to inhibit further transmission of the upstream test sequence.

14) An SU as claimed in Claim 12 or Claim 13 comprising means for delaying the transmission of the upstream test sequence for a random number of frames.

15) A Subscriber Unit (SU) for use in a point to multi-point wireless transmission system as claimed in any of Claims 7 to 11, the SU being substantially as described herein with reference to the accompanying drawings.

16) An Access Point (AP) for use in a system as claimed in any of Claims 7 to 11, the AP comprising means for transmitting sequential downstream data frames, at

least some of which contain a power control identifier field, each power control identifier field containing a unique identifier and defining a time at which an associated upstream power control test field occurs, means for receiving an upstream test sequence from Subscriber Units (Sus), means for determining the received power of the test sequence and means for transmitting a power adjustment field at a later time in the frame or in a subsequent frame, the power adjustment field containing the unique identifier from the power control identifier field and data representing a required transmit power adjustment.

17) An AP as claimed in Claim 16 in which the power adjustment field includes a flag and the AP comprises means for setting the flag when the received signal power of the test sequence is within a given tolerance band of a preset power level.

18) An Access Point (AP) for use in a point to multi-point wireless transmission system as claimed in any of Claims 7 to 11, the AP being substantially as described herein with reference to the accompanying drawings.

Application No: GB 0113887.4
Claims searched: All

Examiner: Dr Jan Miasik
Date of search: 12 February 2002

Patents Act 1977
Amended Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): H4L (LDTP, LETXX)

Int Cl (Ed.7): H04B7/005

Other: Online : Epodoc, WPI, Japio

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	WO 96/38930 A1	(DSC Communications Corporation): pp 5-8	1, 12, 16
X	US 6031828	(Oki Electric Industry Co., Ltd.): cols. 6 & 7	1,2 7, 12, 16
A	US 5991329	(Interdigital Technology): Whole document	
Y	US 5809093	(DSC Communications Corporation): cols. 1 & 2	1, 12, 16
Y	US 5815798	(DSC Communications Corporation): cols. 1 & 2	1, 12, 16

X Document indicating lack of novelty or inventive step
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